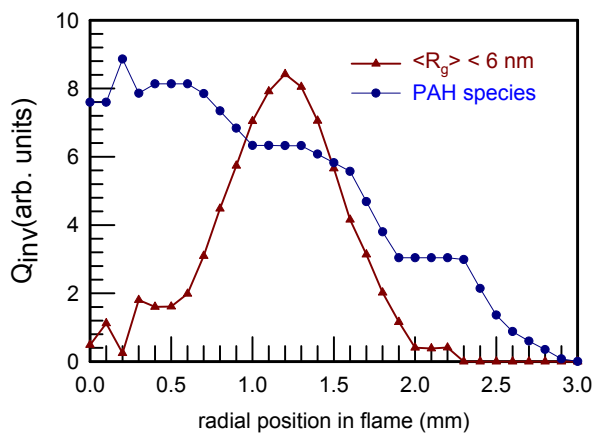
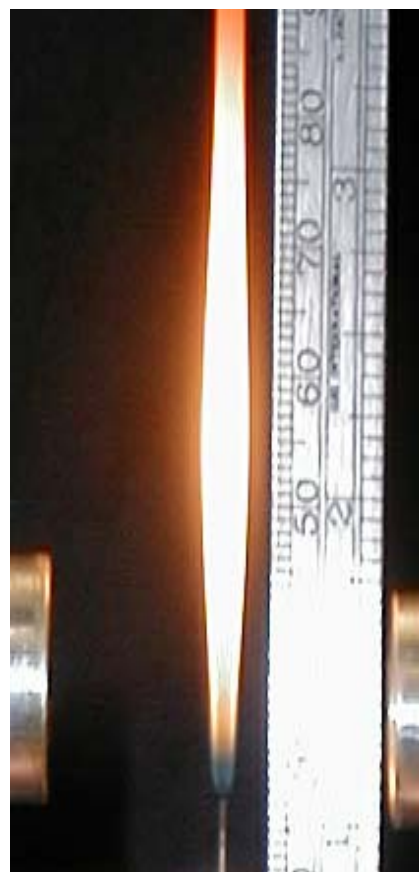
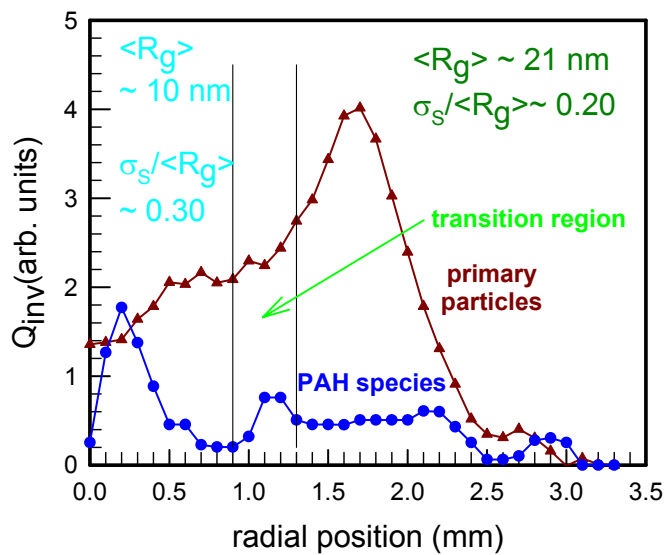


SPATIALLY-RESOLVED SMALL-ANGLE X-RAY SCATTERING STUDIES OF SOOT INCEPTION AND GROWTH

The high spectral brilliance of x-rays produced at the Basic Energy Sciences Synchrotron Radiation Center (BESSRC) of Argonne's Advanced Photon Source (APS) has allowed scientists to measure soot particles as they form and grow in flames. A technique called small-angle x-ray scattering (SAXS), where the number of x-rays scattered by the soot particles is measured at several angles, is used to determine the size and distribution of the soot particles at different positions in a flame. SAXS provides a unique *in situ* probe of particles with sizes between 1 and 100 nm. The photograph on the right of the figure below shows the propylene diffusion flame used for these studies. Two distinct distributions of soot particles are found in this flame. The smaller particles, which require additional experiments before they can be identified, correspond either to soot nuclei or PAH species, such as naphthalene, which are molecules that lead to soot particles. These smaller species are shown as the solid blue dots in the two figures on the left. The larger particles correspond to previously observed primary particles, which have a relatively complex spatial dependence. The graph at the upper left shows the behavior of soot particles at the widest part of the flame. Near the center of the flame the primary particles have a mean radius of 10 nm, between 0.9 and 1.3 mm there is a transition region where they grow to a mean radius of 21 nm, and beyond 1.3 mm the size and distribution of the particles remain relative constant; only their concentration changes. The graph on the lower left shows the behavior midway between the widest part of the flame and the fuel source. Here the larger primary particles have a mean radius of 6 nm, which does not appear to change with radial position. Note, in the lower graph the relative concentration of the smaller PAH species is much larger than in the upper graph.

These and similar studies are used to identify the chemistry and fluid dynamics that control the formation and growth of soot. Since soot has been implicated in global warming and is an important environmental risk factor for cardiopulmonary and lung cancer mortality, we hope that these studies will play a role in reducing the concentration of soot in the environment.

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Figures

The photo on the right shows the propylene diffusion flame used for these studies. The graphs on the left show the relative concentrations of the small species, which are labeled PAH species and shown as solid blue dots, and the larger primary particles, which are shown as the dark red solid triangles.